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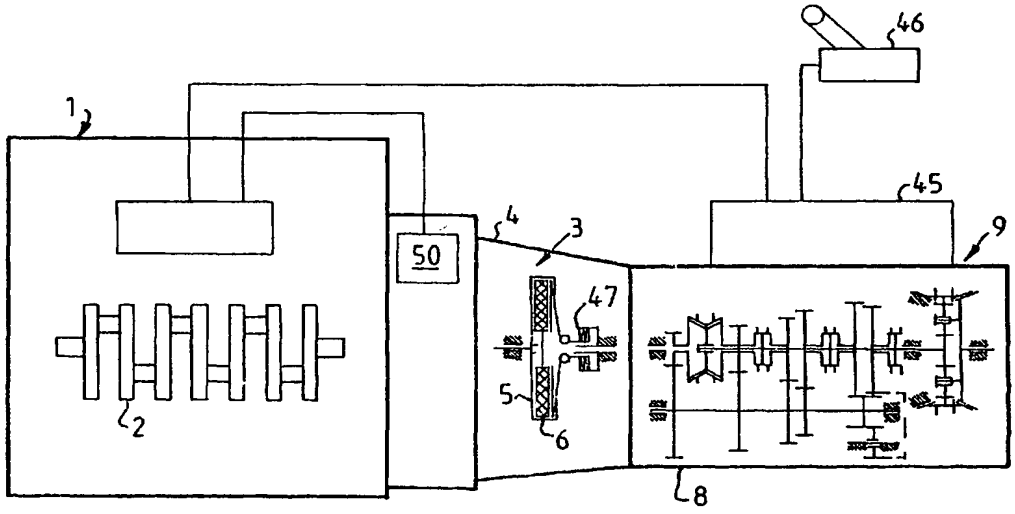
(54) Title: MOTOR VEHICLE DRIVE UNIT



(57) Abstract: Drive unit for motor vehicles, comprising an internal combustion engine (1) and a gearbox (9) connected to the engine via an automated clutch (3), said gearbox (9) consisting of a non-synchronized stepped main group and thereafter a two-range synchronized range group with a free position between its range positions. The clutch and the gearbox are controlled by an electronic control unit (45), to which there are fed signals representing the selected gear from a gear selector (46) and signals representing various engine and vehicle data. The control unit is disposed, when the vehicle is standing still and the gear selector in the free position, to keep the clutch engaged and the range group in the free position. When a gear is selected, the clutch is first disengaged, whereafter the range group is moved to one of the engaged positions to brake the intermediate shaft and make possible engagement of the gear in the main group. After engagement in the main group, the clutch is engaged.

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Motor vehicle drive unit

The present invention relates to a drive unit for motor vehicles, comprising an internal combustion engine and a step gear box input shaft connected via an automated disc clutch to the engine crankshaft, said step gear box having at least one intermediate shaft mounted in a housing, said intermediate shaft having at least one gear in engagement with a gear on the input shaft, a main shaft which is mounted in the housing and has gears engaging gears on the intermediate shaft, at least one gear in each pair of interengaging gears on the intermediate shaft and the main shaft being rotatably mounted on its shaft and lockable by engaging means of which at least some forward gears lack a synchronization function and at least one gear stage between an output shaft and an intermediate shaft having engaging means with synchronization function, and operating means which cooperate with the engaging means and are controlled by a control unit connected to a gear selector, signals being fed to said a control unit representing the selected gear and various engine and vehicle data, at least including engine speed, vehicle speed, clutch position and accelerator pedal position.

Drive units of this type with so-called automatic stepgear gearboxes have become more and more common in heavy vehicles as microcomputer technology has been developed and made it possible, with the aid of a control computer and a number of control means, e.g. servomotors, to precision-regulate engine speed, engagement and disengagement of the clutch and gearbox coupling means relative to each other, so as to always provide smooth shifting, even when shifting between unsynchronized gear steps. The advantage of a step-geared automatic transmission over a traditional automatic transmission, made up of a planet gear stage with a hydrodyna-mic torque converter on the input side, is, on the one hand, particularly when used in heavy vehicles, that it is simpler and more reliable and can be manufactured at a substantially lower cost than traditional automatic transmission, and, on the other hand, that it has a higher efficiency, making lower fuel

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consumption possible. In a gearbox made up of a non-synchronized stepped main group and a synchronized range group, the absence of synchronizations reduces costs even further. The absence of synchronization means makes it possible to make the gearbox shorter or, alternatively, with a set length, make the gears wider than in a synchronized gearbox of the same length, to thereby make it possible to transmit higher torque.

When the vehicle is standing still and the gear selector is in the neutral position, the clutch is normally engaged, so that torque is transmitted from the engine via the clutch to the input shaft of the gearbox and thereby also to its intermediate shaft. This arrangement is often used to drive the gearbox lubricant pump, the gearbox bearings thus being lubricated in this manner even when the gearbox is in neutral when the clutch is engaged. When the vehicle is to start moving, the clutch must first be disengaged before a starting gear can be engaged. If the gear to be engaged is a non-synchronized gear, the interengaging gearwheels on the main shaft and the intermediate shaft must be braked down to almost a standstill before the gear can be engaged. Gearboxes of this type often have very small losses, which means that it would take too long from disengagement of the clutch until the rotating components of the gearbox came to a stop, if the rotating components were not actively braked in some manner. A known method is to use an intermediate shaft brake which rapidly brakes the intermediate shaft down to a standstill when the clutch is disengaged.

The purpose of the present invention is to achieve a gearbox of the type described by way of introduction, which is constructed so that the intermediate shaft can be braked without using separate means solely intended to brake the intermediate shaft.

This is achieved according to the invention by virtue of the fact that the control unit is arranged – starting from zero vehicle speed, clutch engaged and the gear selector in a neutral position – upon movement of the gear selector to a selected position, to first disengage the clutch and then engage a synchronized gearing to brake the

intermediate shaft and thus make possible engagement of a non-synchronized gear. In a gearbox without a range group, the synchronized gear can be any of the forward gears of the gearbox, preferably one of its lower gears, which can be used as a starting-off gear. The control unit is so disposed that if a starting-off gear is selected, which is non-synchronized, after braking the intermediate shaft with the synchronized gear, the control unit disengages the synchronized gear and then engages the selected non-synchronized gear.

In a preferred embodiment of the drive unit according to the invention, the gearbox comprises a main group with a number of gears and a range group with a low range and a high range for each gear in the main group, the range group has clutch means with a synchronization function and has, in addition to a low range position and a high range position, an intermediate neutral position. The control unit – starting from zero vehicle speed, the clutch engaged and the gear selector in the neutral position and the range group clutch means thereby being in its neutral position – is arranged upon movement of the gear selector to the selected gear, to first disengage the clutch, then engage high or low range depending on the selected total ratio and finally, as needed depending on the gear position in the main group, to engage the gear in the main group which provides the selected total ratio.

The invention will be described in more detail with reference to examples shown in the accompanying drawings, where Fig. 1 shows a schematic representation of a drive unit according to the invention and Fig. 2 shows the clutch and the gearbox of Fig. 1 on a larger scale.

In Fig. 1, 1 designates a six-cylinder internal combustion engine, e.g. a diesel engine, the crankshaft 2 of which is coupled to a single-disc dry-disc clutch, generally designated 3, which is enclosed in a clutch bell 4. The crankshaft 2 is solidly joined to the clutch housing 5, while its disc 6 is solidly joined to an input shaft 7 which is rotatably mounted in the housing 8 of a gearbox, generally designated 9.

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A main shaft 190 and an intermediate shaft 11 are rotatably mounted in the housing 8.

As is most clearly evident from Fig. 2, a gear 12 is rotatably mounted on the input shaft 7 and can be locked to such shaft with the aid of an engaging sleeve 13 provided with synchronizing means. Said engaging sleeve 13 is non-rotatably but axial-ly displaceably mounted on a hub 14 non-rotatably connected to the input shaft. With the aid of the engaging sleeve 13, a gear 15, rotatably mounted on the main shaft 10, is lockable relative to the input shaft 7. The gears 12 and 15, respectively, engage gears 16 and 17, respectively, which are non-rotatably joined to the intermediate shaft 11. Additional gears 18, 19 and 20, respectively, are non-rotatably joined to the intermediate shaft 11 and engage gears 21, 22 and 23, respectively, on the main shaft 10 and lockable to the main shaft with the aid of engaging sleeves 24 and 25, respectively, which in the example shown do not have synchronizing means. On the main shaft 10, an additional gear 28 is rotatably mounted and engages an intermediate gear 30 rotatably mounted on a separate shaft 29. The intermediate gear 30 engages in turn an intermediate shaft gear 20. The gear 28 is lockable to its shaft with the aid of an engaging sleeve 26.

The gear pairs 12, 16 and 15, 17 and the engaging sleeve 13 form a splitter group with a low stage LS and a high stage HS. The gear pair 15, 17 together with the gear pairs 21, 18, 22, 19, 23, 20 and 28, 30 form a main group with four speeds forward and one reverse. At the output end of the main shaft 10, a gear 31 is non-rotatably mounted to form the sun gear in a two-range group of planetary type, generally designated 32, the planet carrier 33 of which is non-rotatably mounted to a shaft 34, forming the output shaft of the gearbox. The planet gears 35 of the range group 32 engage a ring gear 36 which, with the aid of an engaging sleeve 37, can be locked relative to the gearbox housing 8 for low range LR and relative to the planet carrier 33 for high range HR. The engaging sleeve 37 also has a neutral position NR lying

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between low range LR and high range HR, in which neutral position the output shaft 34 is released from the main shaft 10.

The engaging sleeves 13, 24, 25, 26 and 37 are displaceable as indicated by the arrows in Fig. 2, providing the gear positions indicated above the arrows. Displacement is achieved by servo means 40, 41, 42, 43 and 44, schematically indicated in Fig. 2, which can be pneumatically operated piston-cylinder devices of the type used in a gearbox of the above described type, which is marketed under the name Geartronic®. The servo means are controlled by an electronic control unit 45 (Fig. 1), comprising a microcomputer depending on signals fed into the control unit representing various engine and vehicle data, including at least engine speed, vehicle speed, clutch and accelerator pedal position and, where applicable, engine brake on-off, when an electronic gear selector 46 coupled to the control unit 45 is in its automatic position. When the selector is in its position for manual shifting, the shifting occurs at the command of the driver via the gear selector 46. The control unit 45 also controls the fuel injection, i.e. the engine speed, depending on the accelerator pedal position and the air supply to a pneumatic piston-cylinder device 47, by means of which the clutch 3 is engaged and disengaged.

According to the invention the control unit 45 is programmed so that the clutch 3 is engaged and the engaging sleeve 37 of the range group is in the neutral position when the vehicle is standing still and the gear selector 46 is in the neutral position. This means that the engine is driving the input shaft 7 and thus also the intermediate shaft 11, while the output shaft 34 is disengaged. Supplementary apparatus driven by the intermediate shaft, e.g. an oil pump for lubricating the gearbox, is driven in this position. The control unit 45 is also programmed, when the gear selector is moved from the neutral position to a gear select position, either to a position for automatic shifting or to a manual position with a starting-off gear selected by the driver, to first disengage the clutch 3 and then put the range group in either LR or HR. The main shaft 10 is thereby connected to the non-rotating output shaft 34,

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which means that the main shaft 10, and the intermediate shaft 11 with it, will rapidly be braked down to standstill. If none of the gears 1-4 in the main group is engaged or if a gear is engaged which does not provide the selected total gear ratio, the control unit will now initiate shifting in the main group to a gear which provides the total gear ratio selected by the automatic transmission or by the driver, and thereafter the clutch 3 can be re-engaged.

The invention has been described above with reference to a gearbox consisting of a main group with a splitter group preceding it, and a range group after it, but can also be applicable to any other non-synchronized gearbox, which has at least one synchronized gear, which can be used as an intermediate shaft brake. The control unit is thus arranged, regardless of what gear is selected as the starting-off gear, to first engage the synchronized gear to brake the intermediate shaft, and then disengage the synchronized gear (assuming that the selected start off-gear is not the synchronized gear) and finally engage the selected gear.

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Claims

1. Drive unit for motor vehicles, comprising an internal combustion engine (1) and a step gearbox input shaft (7) connected via an automated disc clutch (3) to the engine crankshaft (2), said step gearbox (9) having at least one intermediate shaft (11) mounted in a housing, said intermediate shaft (11) having at least one gear (16, 17) in engagement with a gear (12, 15) on the input shaft, a main shaft (10) which is mounted in the housing and has gears (15, 21, 22, 23) engaging gears (17, 18, 19, 20) on the intermediate shaft, at least one gear in each pair of interengaging gears on the intermediate shaft and the main shaft being rotatably mounted on its shaft and lockable by engaging means (13, 24, 25, 26) of which at least some forward gears (24, 25, 26) lack a synchronization function, at least one gear stage between an output shaft (34) and an intermediate shaft (11) having engaging means (37) with synchronization function, and operating means (40, 41, 42, 43) which cooperate with the engaging means and are controlled by a control unit (45) connected to a gear selector (46), signals being fed to said control unit (45) representing the selected gear and various engine and vehicle data, including at least engine speed, vehicle speed, clutch position and accelerator pedal position, **characterized in** that the control unit (45) is arranged – starting from zero vehicle speed, clutch (3) engaged and the gear selector (46) in a neutral position – upon movement of the gear selector to a selected position, to first disengage the clutch and then engage a synchronized gearing (LR, HR) to brake the intermediate shaft (11) and thus make possible engagement of a non-synchronized gear.

2. Drive unit according to claim 1, **characterized in** that the gearbox (9) comprises a main group with a number of gears (1-4, reverse) and a range group with a low range (LR) and a high range (HR) for each gear in the main group, and that the range group has engaging means (37) with a synchronizing function and, in

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addition to a low range position and a high range position, an intermediate neutral position (NR).

3. Drive unit according to claim 2, **characterized in** that the control unit (45) is arranged – starting from a zero vehicle speed, clutch (3) engaged and the gear selector (46) in a neutral position – upon movement of the gear selector to a selected position, to first disengage the clutch and then engage the range dictated by the selected total gear ratio and thereafter engage the gear in the main group which provides the selected total gear ratio.

4. Drive unit according to claim 2 or 3, **characterized in** that the main shaft (10) non-rotatably carries the sun gear (35) in a planet gear set (32), having a planet carrier (33), which is joined to an output shaft (34), and planet gears (35) which engage a ring gear (36), which is lockable by means of engaging means (37) relative to the housing or relative to the output shaft.

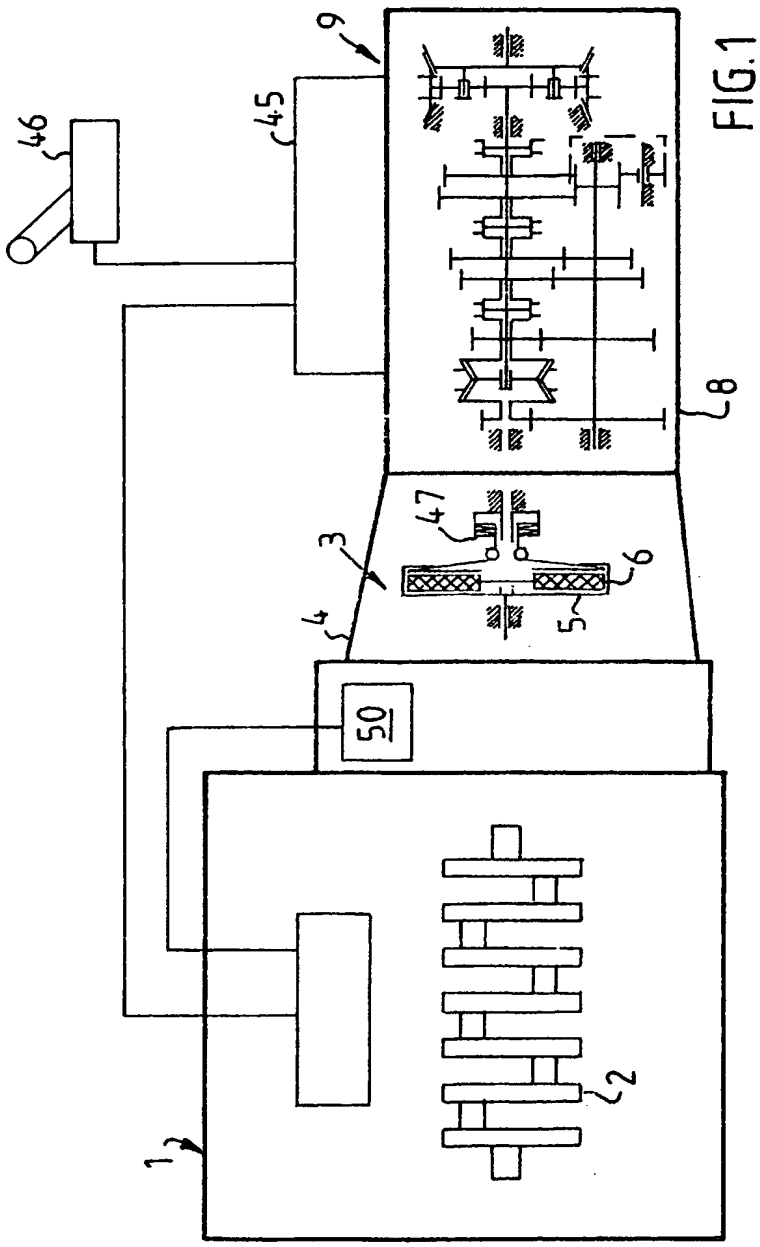

FIG.1

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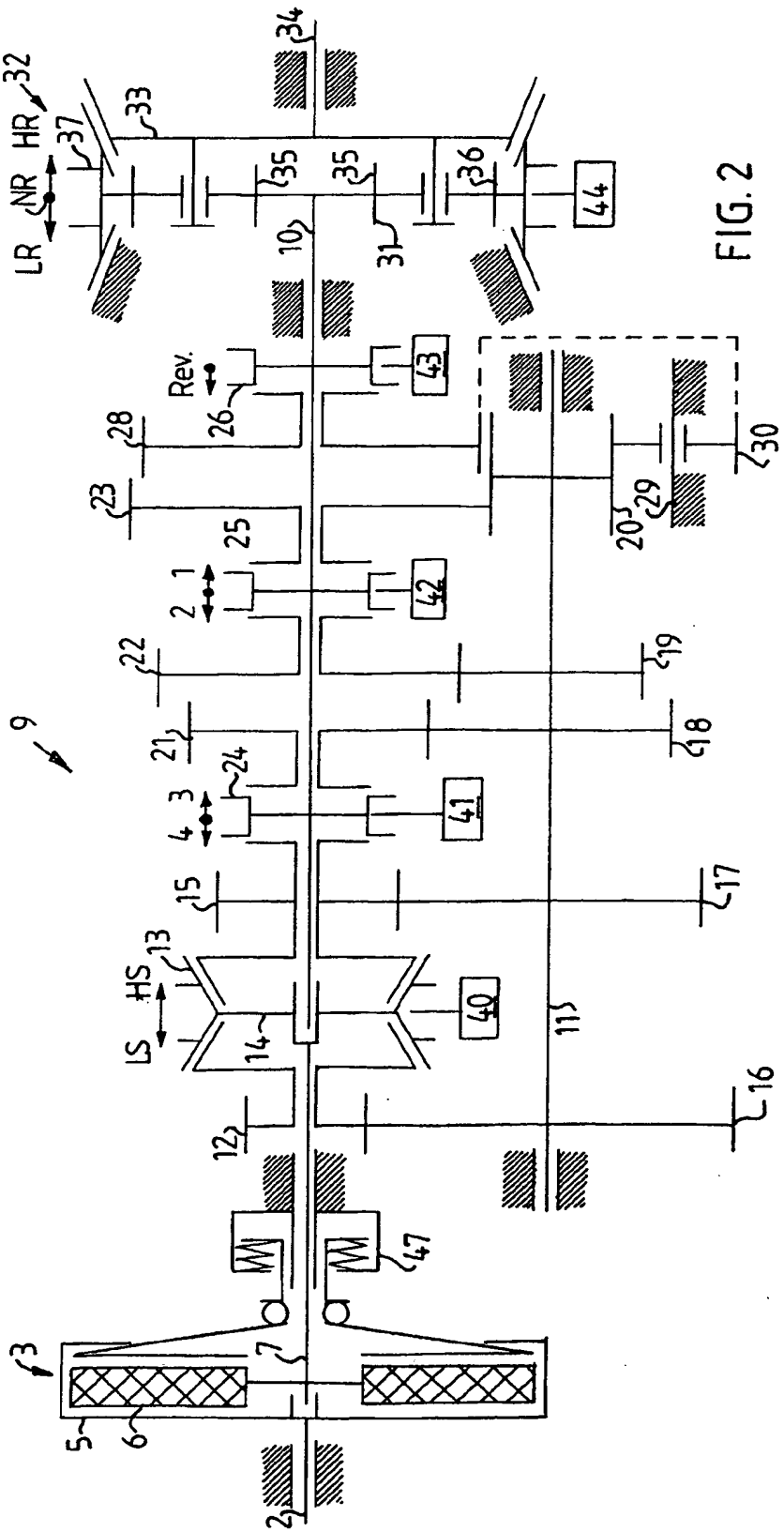

FIG. 2

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/00232

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F16H 3/12, F16H 61/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F16H, B60K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9951891 A1 (DAIMLERCHRYSLER AG), 14 October 1999 (14.10.99) --	1-4
A	US 5503039 A (BAILLY ET AL), 2 April 1996 (02.04.96) --	1-4
A	US 5313856 A (SCHNEIDER ET AL), 24 May 1994 (24.05.94) --	1-4
A	US 4735109 A (RICHARDS ET AL), 5 April 1988 (05.04.88) -- --------	1-4

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
17 April 2002	02 -05- 2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Per-Olof Warnbo / JA A Telephone No. +46 8 782 25 00

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Information on patent family members

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